thus are within the reach of all. It may therefore be fairly pointed out that their rejection by one manufacturer is an act of injustice to others, since nothing can operate more directly to induce government interference with the present unfettered use of steam, than the frequent occurrence of loss of life through the neglect of precautions so simple as those just alluded to.

For the Journal of the Franklin Institute.

On a New System of Arithmetic and Metrology, called the Tonal System. By JOHN W. NYSTROM, C. E.

(Continued from page 348.)

In the ordinary application of mathematics to metrology, it would be best to establish certain notations for the different units to be employed in algebraical formulas and as abbreviation in writing, which would greatly relieve the present confusion and repetition of meaning of letters.

Abbreviation of Tonal Units.

M = *Metre*, unit of length.
 G = *Gall*, unit for capacity.
 T = *Tim*, unit for time and the circle.
 P = *Pon*, unit for weight.
 H = *Horse power*, unit for work.
 D = *Dollars*, unit for money.
 Tp = *Temp*, unit for heat.

The abridgment of the units to be noted by capital letters, and the multiplication and division of the same to be noted by small letters placed before or after the units, thus: Mt.=metons, tM.=tonmetres, Gs.=Gallsans, Ts.=timsans, mP.=millpons, &c., &c.

EXAMPLE 11.—When 309P of butter cost 4.38D, how much will 18.28P of the same cost.

$$309 : 18.28 = 4.38 : X$$

$$X = \frac{18.28 \times 4.38}{309} = 18.36 \text{ dollars.}$$

18.28	3.09) 72.9910 (18.36
4.38	309 ...
-----	-----
8870	3609 ..
5189	3500 ..
6088	-----
-----	901 .
72.9910	

The answer is 18 dollars, 3 shillings and 6 cents.

EXAMPLE 12.—What will be the interest on 3808.65D in 4 years and 5 months, at 9 per sant per annum? (9 per sant is about 6 per cent. decimal.)

Interest = $3208.65 \times 0.09 \times 4.5 = 933.82$ dollars.

EXAMPLE 13.—A yearly payment or annuity of $328.65D$ is standing for 15 years and $\frac{1}{2}$ months,—what will it amount to in that time at $\frac{1}{2}$ per sant interest?

Amount = $328.65 \times 15.5 [1 + \frac{0.08}{2} (15.5 + 1)] = 8849.88$ dollars.

328.65	10.8	5473.127
15.8	0.0058	1.5808
<hr/>	<hr/>	<hr/>
244357	858	29358538
135883	897	39564884.
32865	<hr/>	44587898..
<hr/>	0.5808	29508959...
5473.127		5473127....
		<hr/>

The required amount will be \$8849.3296178

EXAMPLE 14.—When one gall. of fresh water weighs one pon, how much will 5.88 cubic metres of cast iron weigh, when the specific gravity of the iron is 7.212 ?

Weight $7.212 \times 5.88 = 25.84630$ Pons, the answer.

A similar example by the old system will be very complicated. Even in the French metrical system there is more confusion in pointing off the decimals.

EXAMPLE 15.—A locomotive running 39.2^mM per *Tim*, leaves London at $5.84T$; another locomotive on the same track makes 62.0^mM per *Tim*, leaves London at $6.28T$. At how many Millmetres from London, and at what time will the faster locomotive reach the other?

The time of the fast locomotive will be,

$$T = \frac{39.2(6.28 - 5.84)}{6.20 - 39.2} = 0.7 \text{ tims, the answer.}$$

and $6.28 + 0.7 = 6.98$ tims, the time when the fast locomotive reaches the other. Distance from London will be $62.0 \times 0.7 = 30.74$ Millmetres.

Examples in Navigation, Comparing the Old and Tonal Systems.

EXAMPLE 16.—In the year 1861 the sun's declination at Greenwich mean noon is:

	Old System.		Tonal System.
March 13,	$2^{\circ} 48' 36.9''$	=	0.1449 tims.
March 14,	$2^{\circ} 27' 57.3''$	=	0.1878 “
Difference,	<hr/> $23' 39.6''$	=	<hr/> 0.0478 “

Required the true declination of mean noon, on the 13th of March, 1861, in longitude west from Greenwich, $156^{\circ} 40' 23'' = 6.7705$ tims $= 0.67705$ days.

Old System.		
0.4353	156°	360
23 Mult.	60 Mult.	60 Mult.
<hr/>	<hr/>	<hr/>
13059	9360	21600 Min.
8706	42 Add	60 Mult.
<hr/>	<hr/>	<hr/>
10.0119 Min.	9402 Min.	1296000 Sec.
	60 Mult.	
0.0119	<hr/>	
60 Mult.	564120	
<hr/>	23 Add	
0.7140	<hr/>	
Add 39.6 Seconds.	564143 Seconds.	
<hr/>		
40.3140		
40.314		564143.0000
0.4353		5184000 ...
<hr/>		<hr/>
120942		4574300 ..
201570 .		3888000 ..
120942 ..		<hr/>
161256 ...		6863000 .
<hr/>		6480000 .
17.5486842 Seconds.		<hr/>
		3830000
		3888000

from which the correction will be $10' 17.548''$.

Tonal System.	
Diff. longitude	0.67705 days.
Diff. declination	0.0478 tims.
	<hr/>
	580275
	360134
	188024
	<hr/>
Correction	0.01993465 tims.
The required declination will be,	
	$2^{\circ} 48' 36.9'' = 0.1449$ tims.
Correction, add	$10' 17.5'' = 0.0149$ "
True decl.	$2^{\circ} 58' 54.4'' = 0.2144$ tims, the answer.

The old system required seven multiplications, one division, four additions, and employed in the calculation about 215 figures, while the *tonal system* required only one multiplication, and employed only 39 figures for the same object, namely, to find the correction.

The old system required a great deal more knowledge of how to manage the many different operations and figures, and in consequence subject to more errors, while the *tonal system* is simple, clear, and natural to the mind. In working the time and lunar observations, the difference will be still more, on account of angles being expressed both in time and degrees.

In the London *Athenæum* for May, 1862, will be found a very severe notice against the Tonal System. The editor, like others who have made remarks on the same, confines himself to mere triflings and some temporary importance, which have no bearing whatever on the principal utility of the system, and does not even make allowance for its being new to him, but plunges into most fickle expressions. The *Athenæum* editor says: "We have ten thousand million objections to the Tonal System." And "We cannot claim the praise of candid and impartial critics; we will see candor and partiality sanbong tone-metre about 24,852 miles beyond Jericho before we will give them a chance of robbing us of our reckoning." Three barley corns is one inch; $2\frac{1}{2}$ inches is one nail (cloth measure); $4\frac{8}{10}$ nails is one foot; $5\frac{1}{2}$ yards is one rod; 22 yards to the surveying chain of 100 links $7\frac{9}{100}$ inches each; &c., &c., up to different kinds of miles about a peck of barley long each; what a beautiful system of metrology England is in danger of being robbed of. The English themselves do not know where the inch came from (save three corns of barley;) they have been looking for its origin down Egypt, and found a place on the Pyramids where the inch fitted. See *Athenæum* June, 1861, and the *Journal Franklin Institute*, Nov., 1861.

There must have been a great many *Athenæum* editors to resist the robbers of the Roman notation which was kept up in public accounts in England almost to the present day, and lately abolished at the expense of burning the Houses of Parliament; if our present barbarous decimal arithmetic and metrology could be abolished and the Tonal System introduced at the same expense, I would propose to burn down that structure immediatly, for the Houses of Parliament are not worth a farthing compared with a natural system of counting. The *Athenæum* editor says that it is "poor argument to grumble about long decimal tails," and that, "The decimal system avoids long decimal tails—if fractions be meant—in twice as many cases as the Tonal System." It will not be more out of reason to say that a sheep's tail is twice as long as an ox's tail, which the editor may succeed to plug into such readers of the *Athenæum* who have never seen a sheep and an ox. As regards decimal tails we have only to refer to a table of logarithms, where we find no end to them. Oliver Byrne has calculated those decimal tails for the single figures up to fifty places, and found no end; while the Tonal logarithms finishes it off correctly at the first and second places. The same with figures in daily use in the shop and the market, the deci-

mal tails are snubbed off to an approximate value, where the Tonal System gives a clear and correct result with the fewest possible figures. As example I have only to refer to my ordinary practice of calculation, for instance, the tables on page 321, eighth edition Nystrom's Pocket Book, which is calculated by the parabolic formula.

$$x = \frac{y^n b}{l^n}.$$

Let us assume values on the letters to $y = \frac{3}{8}$ or 0.375, $b = 1$, $l = 1$, and the exponent $n = \frac{5}{8}$ or 0.625. Required the value of x in the decimal and tonal systems.

Decimal.	Tonal.
Log. 0.375 = 0.5740313 — 1	Log. 0.6 = .096 — 1
multiply by $n = 0.625$	mult. $n = 0.9$
<hr/>	<hr/>
28701565	0.670 — 1
11480626	— 0.9
34441878	<hr/>
<hr/>	Log. 0.898 = 0.070 — 1
0.3587695625 — 1	$x = 0.898$, the answer.
— 0.625	
<hr/>	
Log. 0.5417 = 0.7337695625 — 1	
$x = 0.5417$, the answer.	

The long decimal tails consist of 64 figures, while the tonal system employs only 14 figures for the same calculation. The three tonal places are more correct than the four decimals. This is what the *Athenæum* editor calls "poor argument." Poor editor, I do not suppose decimal tails trouble him much.

Lastly, the editor remarks, "Nevertheless, seeing that there cannot be an age of speculation, without cases of extreme indiscretion, we welcome this book as a proof of active mind," showing how far an editor can go when he does not know where he is going. If we could by some means or another pump into the editor of the *Athenæum* only a few advantages of the tonal system, he would surely be so delighted in joy that he would go to the other extreme and cry out, "*matuschka, matuschka*, what an indiscretion that decimal system is." Unfortunately for the editor, he is no doubt sincere in his remarks, sorry though for mankind, to know that such conception can exist in what we might call a centre of civilization.

Let us now apply the tonal system to printing, and we may succeed in bringing it under the *Athenæum* editor's conception. We find that the *Athenæum* is printed from a form of 16 pages, which is 10 tonal, and the whole sheet is 32 pages or 20 tonal. Printing forms are generally made up into 8, 16, 32, &c., pages, and in exceptional cases, for what is called a *medium and a half* sheet, the form is divided into 12, 24, and 48 pages, but we never find a printing form divided into ten pages, and if the *Athenæum* Editor tries to fold a sheet of paper into ten

pages, it will puzzle him more than the tonal system. The critic was probably written by the Professor who generally writes on mathematical work in the *Athenæum*, the author of most parts of the observation on decimal coinage, a very bigoted Professor when on opinion.

ERRATA.

In the article on the "Tonal System," in the November Number of the Journal, reference is made to the tonal metre, fig. 1, drawn on the rule fig. 3, Plate I.: *fig. 1 and the scale* were left out by the lithographer, and the proof sheet did not come under my notice. This figure can be seen in the work on the Tonal System, published by J. B. Lippincott & Co., Philadelphia, which contains a more full description and discussion on the new system. N.

A Dictionary of Mechanical Fallacies.

To the Editor of the Journal of the Franklin Institute.

The suggestion of *A Dictionary of Mechanical Fallacies*, including superseded devices, in a late number must, I think, commend itself not only to inventors and the Patent-Office, but to every mind interested in the progress of the Arts. But who is to prepare it? It would require the lifetime of an individual. It should, I submit, be the work of, or got up under the auspices of a society that can command a wide correspondence at home and abroad. It would gratify many to learn that the Franklin Institute had taken the subject into consideration. It may be too much to expect a Journal should be devoted to the collection of material, but a portion of one or more established ones might be given up to it. A couple of pages thus occupied would detract nothing from the interest of any monthly mechanical serial. There is probably not one whose pages have not indicated the want of such a work.

Among the premiums awarded last year by the justly celebrated "Société d'Encouragement" of France, is one for a process of tinning leaden pipes, in use here over twenty years ago, and pronounced in 1842, by the United States Court for this district, an infringement of a patent of 1835.

The United States Government can never make a wiser or more profitable appropriation than one to forward such a work. It would reduce by two-thirds the expense and labor of our Patent-Office, and in proportion those of any foreign ones.

There are few thoughts purely new; few of which the germs have not been previously developed. The idea of your correspondent, E, does not appear to be quite original with him. Sir Walter Raleigh, at one time endeavored to reduce to practice a suggestion of Montaigne, by establishing an "Office of Address," intended to serve the purposes now effected by literary and philosophical societies and journals.

The description of the scheme, given by Sir William Petty, affords a striking picture of the difficulties and obstacles which lay in the way of men of study and inquiry between two and three centuries ago.